Floral Flavors and the Duality of Smell: Impact of odorant delivery and provided information

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Abstract

The olfactory sensory system encompasses two pathways that perceive odor molecules: the orthonasal pathway, through the nose, and the retronasal pathway, through the mouth. Although both pathways are theorized to activate the same receptors in the olfactory epithelium, they elicit different sensations and perceptions, which is referred to as the Duality of Smell hypothesis. Additionally, there are different cognitive strategies humans employ to identify different flavors that impacts their perception. In this study, a matching activity was employed to evaluate similarities and differences of these two pathways (orthonasal and retronasal) using a novel flavor set, being floral flavors. Four isointense aqueous floral flavors (honeysuckle, lavender, rose, and jasmine) were used to determine the impact of delivery route on flavor perception. To alter the cognitive strategies used by panelist, three different reference labeling methods were utilized for the same flavors at the same concentration levels, familiar (honeysuckle, lavender, rose, jasmine), unfamiliar (inodora, pedunculata, beggeriana , didymum), and generic (A, B, C, and D). Participants (n=34) were presented with a reference, either in a vial (orthonasal delivery) or a 2 oz. cup (retronasal delivery), and instructed to match the same aroma from four unknowns, evaluated either by the same delivery route (congruent) or different route (incongruent) than the reference evaluation. This was then repeated for all possible combinations of orthonasal and retronasal delivery (four total delivery conditions). From the results it was shown that panelist performed significantly better ($p<0.05$) in the congruent conditions (orthonasal-orthonasal, retronasal-retronasal) than in the incongruent conditions (orthonasal-retronasal, retronasal-orthonasal), which further supports the Duality of Smells hypothesis and proves that the duality of smell is retained even with samples with low retronasal familiarity. Overall, there was no significant difference in matching ability between the different labeling conditions, suggesting panelist's cognitive strategy was similar in all three conditions. Trends, however, show that there may have been an effect as labeling method was altered, indicating the need for further research in this space.

Keywords: Olfaction, orthonasal, retronasal, floral flavors, cognitive strategy

Introduction

Olfaction is the sensory system that is more commonly referred to as smell. This system is generally thought of to be solely through the nose, but in reality, olfaction encompasses two different pathways, the orthonasal and retronasal pathway. These pathways both take in odor molecules, which are airborne volatiles, and then trigger receptors in the olfactory epithelium, leading to a perceptual response (Ache & Young, 2005). Orthonasal olfaction occurs when odorants travel from the anterior nares, or nostrils, to the olfactory mucosa from inhalation or sniffing. Retronasal olfaction occurs when odorants are taken in through the posterior nares in the back of the throat, which are released through chewing, swallowing, and exhalation (Pierce & Halpern, 1996)(Bojanowski & Hummel, 2012). Orthonasal olfaction is relatively easy to analyze in isolation. On the other hand, gustatory and chemesthetic cues present within the oral cavity, make it difficult to evaluate retronasal olfaction in isolation (Kuo, Pangborn, & Noble, 1993). Due to retronasal olfaction occurring in the oral cavity, it is often confused with taste, or gustation, since that is the main sense associated within the mouth. However, taste encompasses only the sweet, sour, salty, bitter, and umami sensations perceived on the tongue, while flavors like floral and fruity are aromatic sensations perceived through retronasal olfaction (Small, Gerber, Mak, & Hummel, 2005).

Since this sensory system consists of two pathways, it is considered the only "dual sense modality" in humans. While both pathways activate the olfactory epithelium, research has found they result in different perception (Rozin, 1982) (Hannum, Stegman, Fryer, & Simons, 2018). Research suggests these pathways might be two distinct olfactory systems and the difference in airflow patterns and direction the odorants travel across the olfactory epithelium might underpin the difference in perception (Mozell, 1964). Similarly, it has been proposed that interactions with other sensory systems such as gustation could cause activation of different brain areas to interact (Mozell, 1964) (Small, et al., 2004). However, there is still much to be understood about the mechanistic differences between the two pathways. Additionally, we are interested in understanding how cognition might influence perception and performance across these different pathways.

Aromas originating outside the body, like floral aromas, are relatively foreign in the oral cavity and therefore, a person's subjective experience is often only a result of the orthonasal pathway. This leads to the question if there are deviations to the "Duality of Smell" hypothesis when an olfactory stimulus is less commonly experienced as an odorant or flavorant. Work with specific floral odorants has been moderately limited, especially in the retronasal space. This is due to the previous lack of desire to consume foods with solely floral flavors, but trends have shifted to encompass an increased use in beverage and food applications. The increase of use in these products means that these flavor volatiles are now being released in the oral cavity and perceived through the retronasal pathway as opposed to solely the orthonasal pathway. It has been theorized that olfactory perception is experience-bound and when an odor is experienced with a taste, which can only occur in the oral cavity, the odor takes on the quality of the taste (Stevenson, Prescott, & Boakes, 1995). Since floral flavors have an established olfactory perception independent of the taste qualities, a difference may be observed in route-dependent perception when comparing to volatiles that are experienced with a taste.

Along with perceptual differences dependent on the route of delivery (orthonasal versus retronasal), and therefore, ability to correctly match an unknown flavor to a reference, cognitive strategy also has an effect. It has been theorized that the memory system for odors is unique and separate than other sensory modalities (Zucco, 2003). In this study, it was found that interference during recognition activities impacts visual and acoustic stimuli but has no impact on odor recognition. Along with the memory system being unique, it has been observed that there is no impact on familiarity of odor nor pleasantness of stimuli on recognition (Engen & Ross, 1973). Additionally, the relationship between odors and words are weak, which has indicated that giving odors meaningful labels has no effect on recognition (Lawless & Cain, 1975). However, there have been some contradictory results in other studies. Another work showed that as familiarity of the stimuli, and therefore their labels, decreased, matching ability did as well (Hannum, Stegman, Fryer, & Simons, 2018). This work used three different sets of stimuli, but between each the labeling provided varying levels of information, from familiar and differentiable, to almost undifferentiable with the only differentiation being the assigned letter, with matching ability decreasing between them. Additionally, it was also observed in a study where panelists were asked to smell thirty odors and then provide one of the following, name with short definition, image, life episode, or just smell, that when asked to identify these odors from a larger set a week later, the name and life episode panelists showed the lowest false alarm scores (Lyman & McDaniel, 1986). The hit scores, however, did not show significant difference but indicate that there is a stronger attachment and recognition ability when individuals are provided with a name and emotionally loaded stimuli. These varying results indicate that the impact of memory based cognitive strategies on odor identification is still to be fully discovered.

This present experimentation was done as an extension of the work done by Hannum et al in 2018 to further look at the intricacies of human perception in the olfactory system. To expand on this work, four identical flavors with the same panelists were utilized throughout the entire study to be able to determine the impact of changing labels in isolation. By using a matching paradigm and manipulating cognitive strategies through altering the level of familiarity of the references, we sought to determine 1) if olfactory perception is dependent upon the route of delivery 2) if floral volatiles and relative low retronasal exposure impacts the duality of the olfactory system and 3) if cognitive strategies employed when provided with varying levels of information affect performance in a matching task, indicating that verbal ques impact olfactory recognition. It is hypothesized that there will be no significant differences in correctly matching an unknown sample to a reference when the reference and unknown are evaluated via the same pathway but will show difference when evaluated via different pathways, thus further confirming the Duality of Smell hypothesis. Also, the number of correct matches for each participant in the congruent conditions, meaning same pathway, will be significantly higher than those in the incongruent pathways. For the impact of labeling on cognitive strategy, it is hypothesized that the familiar labeling will have more correct responses overall, followed by unfamiliar labeling, and generic labeling showing the least, even though all the flavors are the same in each condition.

Materials and Methods

Subjects. Thirty-four panelists (9 males, 25 female) ranging in age from 20 to 35 participated in all three experimental sessions. They were recruited from The Ohio State Department of Food Science and Technology, eliminating anyone who had participated in similar aroma perception studies. Protocols were approved by the OSU Institutional Review Board. All panelists were asked for written consent, in good health, and had no taste or smell deficits. Panelists attended a total of three sessions, two weeks apart. The session lasted approximately 1 hour, and all panelists were compensated $20 at the end of each session. All responses were recorded on a computer interface using Compusense Cloud software (Guelph, Canada).

Materials. Four floral flavors that were found to be similar but differentiable were selected and included honeysuckle, lavender, rose, and jasmine (MANE, Cincinnati, OH). These flavors were used in all three experimental sessions.

Flavors used for orthonasal evaluation were cut in distilled water and placed into amber colored glass capped vials in order to eliminate any potential color bias. Flavors used for retronasal evaluation were dissolved in distilled water and served in black, 2oz cups (Dixie, P020BLK). Intensity levels were determined using a preliminary panel (n=10). Stimuli levels were selected to elicit moderately intense flavor/aroma with no taste or chemesthetic qualities (Table 1). The lack of gustatory or chemesthetic quality was confirmed during the debriefing of the panelists that was conducted at the conclusion of each experimental session.

The reference cups and vials were labeled with varying identifiers across the three experimental sessions (Table 2). For one week, the references would be labeled with the common name of the flavors: Honeysuckle, Lavender, Rose, and Jasmine. During another week, they were labeled with unfamiliar names, respectively, utilizing a species name from the four floral genus': Inodora, Pedunculata, Beggeriana, Didymum. The final labeling method was generic, with the references labeled simply A, B, C, D.

Table 1. Stimuli concentration levels for orthonasal and retronasal evaluation in water for each flavor created on a volume by volume basis (mL flavor/mL water) for all three experimental sessions.

Flavor	Orthonasal Concentration Level	Retronasal Concentration Level
Honeysuckle	0.10%	0.10%
Lavender	0.40%	0.40%
Rose	0.05%	0.05%
Jasmine	0.10%	0.15%

Experimental Protocol. Each session included four conditions and followed the experimental design adapted from Hannum et al. (2018). Each panelist was presented with a metal tray containing four rows and five columns of samples. For each row, panelists were instructed that the first sample was the reference sample and that they must identify the matching sample from amongst the 4 unknowns in the same row. The references on each tray included one of each floral flavor, labeled with the name indicated by the given labeling session (Table 2), while the samples for matching were presented with blind 3-digit codes, with the order being randomized and counterbalanced across panelists. Once finished evaluating all four references in a tray, panelists were presented with the next tray, for a total of 4 trays (one for each delivery condition) per session. In one delivery condition, the reference was presented orthonasally and then matched orthonasally (ON-ON). In another condition, the reference was presented retronasally and then matched retronasally (RN-RN). These are classified as the two congruent conditions. The reference was presented orthonasally and matched retronasally (ON-RN) in a third condition, and the reference was presented retronasally and matched orthonasally (RN-ON) in a fourth condition. These were classified as the incongruent condition since the panelists were matching across the different modes of aroma perception. The conditions were presented to each panelist in a randomized and counterbalanced order, with each condition containing unique blinding codes. Panelists were asked to rinse well with water after drinking each of the samples to cleanse their palette and smell water to clear any lingering scents after smelling. Saltines for additional palette cleansing were also available at the panelists request.

The panelist then returned for 2 additional sessions, for a total of 3 sessions, with a 2-week separation in between. The samples, experimental protocol, and randomization of conditions were identical from session to session, with the only difference being the labeling of the reference (Table 2). The panelists were not told if the samples were the same or different from week to week. The session order was randomized for each panelist.

Table 2: Labeling methods used to manipulate cognitive strategy.

Familiar	Unfamiliar	Generic
Honeysuckle	Inodora	Flavor A
Lavender	Pedunculata	Flavor B
Rose	Beggerina	Flavor C
Jasmine	Didymum	Flavor D

Data analysis. To determine if a significant portion of panelists performed better in the congruent conditions versus the incongruent conditions within each labeling method, binomial analysis was used. McNemar's test was used to determine if a significant difference existed in performance between each of the four delivery conditions within each labeling method. This method was also used to determine if there were differences in performance between flavors within each labeling method. Chi-square was used to determine whether the distribution of responses differed significantly across labeling methods. All data are presented as counts or percentages. An $\alpha < 0.05$ was taken as significant.

Results

Experiment 1 - Familiar labeling. The overall performance of correct matches in this condition ranged from 49% to 64% for all 4 delivery conditions (Figure 1A). The percentage of panelists correctly identifying of the matching stimulus within each condition is shown in Figure 2A. The increased difficulty in correctly matching stimuli when presented in the incongruent conditions is indicated by leftward shift in the percentage of correct matches for the ON:RN and RN:ON trials (Fig 2A). This is further supported by the finding that the total number of correct matches in each delivery condition indicated no significant difference between the two congruent conditions (ON-ON:RN-RN, p=0.45) nor the two incongruent conditions (ON-RN:RN-ON, p=0.20) but the congruent and incongruent groups being significantly different (ON-ON:ON-RN, p=0.006; RN-RN:ON-RN, p=0.007; ON-ON:RN-ON, p=0.01; RN-RN:RN-ON, p=0.056, shown in Figure 1A). This confirms the duality of smell hypothesis, indicating that the perception and therefore recognition of odors is dependent on route. However, at an individual level, as displayed in Table 3, individual panelists performed similarly in all the delivery conditions as there was not a significant majority of panelists who performed better in the congruent compared to the incongruent conditions (p=0.061)

Experiment 2 - Unfamiliar labeling. When the stimuli was presented with unfamiliar labels, the overall performance of correct matches ranged from 47% to 64% for all 4 delivery conditions (Figure 1B). The percentage of panelists correctly identifying of the matching stimulus within each condition is shown in Figure 2A. Compared to the familiar condition, there was a right shift in the number of correct responses (Figure 2B).There was no significant difference between the two congruent conditions (ON-ON:RN-RN, p=0.50) nor the two incongruent conditions (ON-RN, RN-ON, p=0.22) for overall number of correct matches in each condition but there was significant difference between these two groups (ON-ON:ON-RN, p=0.05; RN-RN:ON-RN, p=0.03; ON-ON:RN-ON, p<0.001; RN-RN:RN-ON, p=0.003), shown in Figure 1B. This again supports the duality of smell hypothesis. Individually, panelists performed equally well in both the congruent and incongruent conditions (p=0.100, Table 3).

Experiment 3 - Generic labeling. The overall performance of correct matches in this condition ranged from 51% to 75% for all 4 delivery conditions, which is slightly higher than the other two labeling conditions (Figure 1C). The distribution of number of correct matches shows a shift towards a higher number of correct matches compared to the familiar and unfamiliar labeling conditions. The differences observed for the total number of correct matches in each condition showed that there was no significant difference between the two congruent conditions (ON-ON:RN-RN, $p=0.97$) nor the two incongruent conditions (ON-RN, RN-ON, $p=0.34$) but there was significant difference between these two groups (ON-ON:ON-RN, $p<0.001$; RN-RN:ON-RN, $p=0.01$; ON-ON:RN-ON, $p<0.001$; RN-RN:RN-ON, $p=0.002$) as shown in Figure 1C. This, for a third time, supports the duality of smell hypothesis. However, a difference with this labeling method is that significant number of panelists ($p<0.001$) performed better in the congruent conditions than the incongruent conditions (Table 3).

Cognitive Strategy. Since the stimuli were kept consistent across all three labeling methods, the use of different cognitive strategies to correctly identify the correct match when presented with varying levels of information can be observed. In comparing across the labeling conditions, there is a positive shift observed in number of correct matches made by a panelist as the information provided decreased and the reference labels change from familiar to generic labeling (Figure 2). However, when analyzing overall performance across the three labeling conditions there was no significant difference.

Flavor Difficulty. In each delivery method, it was assessed whether there were any differences due to inherent difficulty with each flavor. Even though the flavors were consistent across all three labeling conditions, in the familiar and unfamiliar labeling conditions, there was evidence of certain flavors being more difficult to match, while in the generic condition all flavors were equally matched (Table 4). In the familiar labeling condition, lavender was correctly matched significantly more times than honeysuckle ($p=0.04$, Table 4). In the unfamiliar labeling condition, there was more evidence of inconsistency in matching ability across the flavors. Rose showed significantly more correct matches than honeysuckle ($p=0.008$) and jasmine (p=0.001, Table 4). Surprisingly, all flavors were equally matched when presented with generic labeled references as no flavor was significantly harder to match across the delivery conditions than another flavor (Table 4).

Table 3: Number of panelists who individually performed better (p<0.05) within each labeling method

	Familiar Labeling	Unfamiliar Labeling	Generic Labeling
Congruent Sessions	18	19	25
Incongruent Sessions	9	11	3
Neither	7	4	6
P-value (1-tailed)	0.061	0.100	<0.001

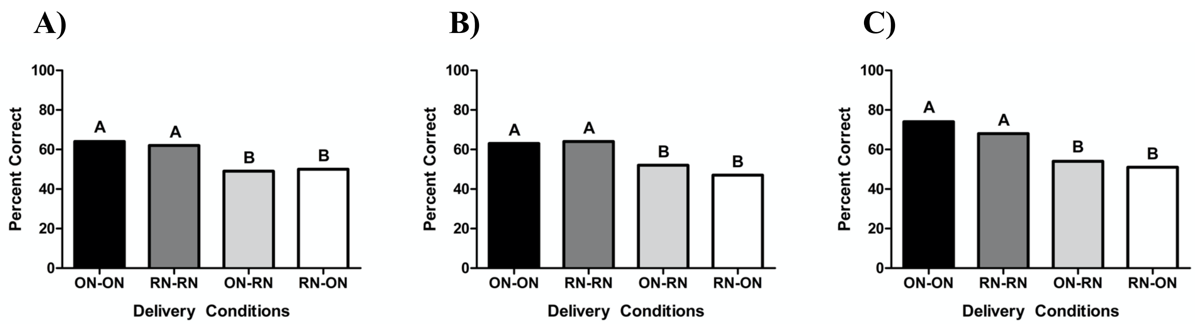

Figure 1: Overall matching performance across all flavors for each delivery condition in each labeling method. (A) Familiar labeling (Honeysuckle, Lavender, Rose, Jasmine); (B) Unfamiliar labeling (Inodora, Pedunculata, Beggeriana, Didymum); (C) Generic labeling (Flavor A, Flavor B, Flavor C, Flavor D). ON-ON: reference and unknown stimuli presented orthonasally. RN-RN: reference and unknown stimuli presented retronasally. ON-RN: reference stimuli presented orthonasally and unknown stimuli presented retronasally. RN-ON: reference stimuli presented retronasally and unknow stimuli presented orthonasally. Same letter above bars indicates no significant difference between sessions as determined by McNemar's test.

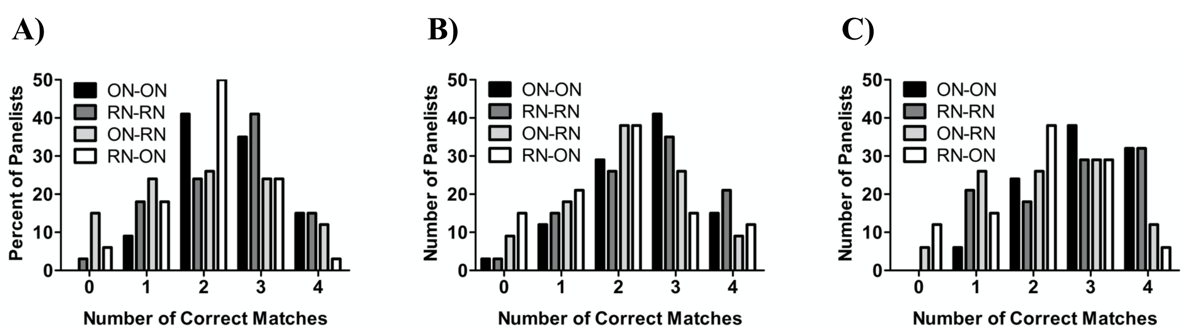

Figure 2: Distribution of number of correct matches within each delivery condition in each labeling method. (A) Familiar labeling (Honeysuckle, Lavender, Rose, Jasmine) (B) Unfamiliar labeling (Inodora, Pedunculata, Beggeriana, Didymum) (C) Generic labeling (Flavor A, Flavor B, Flavor C, Flavor D).

Table 4: Flavor matching difficulty determined using McNemar's test based on comparing number of correct matches across all four conditions. Values depicted are the p-values associated with each comparison. Asterisk indicate significant difference (p<0.05).

Experiment 1 – Familiar Labeling				
	Honeysuckle	Lavender	Rose	Jasmine
Honeysuckle	1.00	0.04*	0.20	0.36
Lavender	-	1.00	0.22	0.07
Rose	-	-	1.00	0.36
Jasmine	-	-	-	1.00
Experiment 2 – Unfamiliar Labeling				
	Inodora	Pedunculata	Beggeriana	Didymum
Inodora	1.00	0.13	0.008*	0.40
Pedunculata	-	1.00	0.10	0.06
Beggeriana	-	-	1.00	0.001*
Didymum	-	-	-	1.00
Experiment 3 – Generic Labeling				
	Flavor A	Flavor B	Flavor C	Flavor D
Flavor A	1.00	0.35	0.40	0.21
Flavor B	-	1.00	0.50	0.13
Flavor C	-	-	1.00	0.14
Flavor D	-	-	-	1.00

Discussion

The results of the present experiment have further supported the hypothesis that olfactory perception is based on the delivery route of these odorant molecules, whether it be orthonasal or retronasal delivery. Across all 3 labeling methods (familiar, unfamiliar, and generic), using the same flavor stimuli, panelists correctly matched more samples when evaluated via congruent routes (ON-ON; RN-RN) then when evaluated via incongruent routes (ON-RN; RN-ON). As the labeling method changed from familiar to generic reference names, the trend in matching ability was observed to increase as provided labeling information decreased, though, this was not significant. However, it is seen that there is greater resolution of the duality between the two delivery routes, with greater differences being observed between overall performance in the congruent and incongruent conditions, in the generic condition. The level of difficulty in matching was not consistent across all flavors as lavender and rose were more often correctly matched. This was not originally hypothesized to be affected by the change in labels, due to the samples being identical, but this result could further show the impact previous experience has on the cognitive strategy employed to differentiate the samples with each labeling condition.

Different Delivery Conditions. For the delivery conditions , it was expected that the congruent conditions (ON-ON; RN-RN) would show a significant increase in matching accuracy compared to the incongruent conditions (ON-RN; RN-ON), which would further confirm the Duality of Smell (Rozin, 1982). Indeed, we found that across all labeling conditions, the number of correct matches were greater when the reference and unknowns were presented via the same pathway compared to when they were delivered via different pathways. This result confirms our hypothesis and further confirms the duality of olfaction, indicating that although the same odorant molecules are triggering the same receptor, they elicit different responses based on the delivery pathway. Therefore, on an individual level we expected to observe a similar breakdown in performance between congruent and incongruent conditions. However, in two of the three labeling conditions, this was not observed, as each panelist generally performed equally well across the congruent and incongruent conditions. The differences when looking at overall performance versus the individual performance on the duality of smell are most likely due to individual differences in matching ability and familiarity with the stimuli. This agrees with previous work where it was also shown that when samples appeared with familiar labels, there was no significant difference found (Hannum, Stegman, Fryer, & Simons, 2018). This indicates that the labeling does have an impact on matching ability. However this previous work also indicated that overall and individual performance was similar, indicating the duality of smell was not observed. The differences observed between these two works is most likely due to the inherent difficulty of the floral flavors, since there is a lower matching ability overall, and each panelists experience of these flavor that impacts their perception.

Different labeling conditions. Figure 2 displays the correct response rate for each panelist within a labeling method. A shift to the right, therefore, increased individual correct response rate, is observed with the decrease in information provided, moving from the familiar labeling condition to the generic labeling condition. This observation suggests that individual performance was influenced by the cognitive strategy as we see an increase in accuracy, even though the flavors were the exact same across all labeling conditions (familiar, unfamiliar, generic). Panelists had to employ different profiling strategies to match the samples when they were provided with their familiar names then when they were generically labeled, since the latter provides no information to aid in differentiation. The unfamiliar names, although not providing the same level of information as the familiar names, were based off the Latin names of the floral flavors and panelists may have used these names as part of their profiling strategy, since each sample indicated that they were different species. In the generic condition, there was no preconceived notion of what the sample is and should smell like nor was the direction of difference provided. This forced panelists to actively analyze the samples more closely to determine the match, which may account for the increased matching accuracy. This experimentation was an extension of the work by Hannum et al (2018), which showed disagreement with the findings from this work. In that study, it was found that as information decreased, matching ability decreased. The differences observed in this experimentation is most likely due to the use of the same flavors across the varying familiarity of the labels instead of altering the familiarity of the flavor samples as well.

Although there was a shift observed, when comparing overall performance in each labeling condition, no statistical significance was found. This agrees with the previous works done by Lawless and Cain (1975) that found labeling to have no effect on olfactory recognition. However, the trends found through this work suggest that there should be further research to determine the validity of this theory. Although all limitations were attempted to be minimized, there are some that may have led to this lack of significance. First, finding the isointensity of the solutions is based solely on a small preliminary panel, and not the panelists themselves. Isointense levels can vary from person to person and this should be taken into stronger consideration for future work. Next, this sample set is inherently more difficult than other flavors, which is observed from the lower performance when compared to other studies. This may have caused significance to not be found since the spread of data was not wide enough. Also, since this sample set can have a large variety of experience levels from panelists and their previous experience was not taken into consideration for recruitment, this may have led to discrepancies within the study.

To further look at the impact on cognitive strategy, when comparing the number of panelists that performed better overall in the congruent conditions versus the incongruent conditions, the only labeling method to show significant difference was the generic condition. This indicates that with this labeling, the duality of smell hypothesis showed more resolution which is likely because of the removal of all bias due to memory and previous experience. When provided with the name of aroma in the familiar condition, panelists depended on previous experience with these floral volatiles. However, since these are concentrated flavor solutions, they might be perceived differently than when smelled in daily life (i.e. perfume, candles, flowers) or when consumed. Also, these floral aromas were experienced in isolation and therefore, are perceptually different than what panelists expectations are. This indicates that previous experience is not the best basis of which sample matches the reference, since perception is the integration of multiple sensory inputs that provide a unitary perception (Small & Prescott, 2005). This can explain why the generic labeling was the only condition to show a significant difference between those who performed better in the congruent conditions versus the incongruent conditions. In the moment of evaluation, panelists relied on their pure perception of the volatiles instead of using the name and preconceived perception as a part of their matching strategy.

Different Flavors. Differences were observed when looking at performance across the flavors indicating that matching ability was dependent on the flavor presented as well. The panelists had difficulties with certain floral flavors over others, which changed based on the labeling conditions. This was not an expected result of the experimentation, since flavors were all the same across the labeling condition and were chosen to be similar but differentiable, therefore requiring an equal ability to match. Overall, lavender and rose showed the highest performance across all three labeling methods while honeysuckle and jasmine showed the lowest. This is most likely due to the general lack of familiarity of honeysuckle and jasmine when compared to lavender and rose. Lavender and rose are used in many perfume products and have begun to enter the retronasal space, with beverage and bakery applications. While jasmine and honeysuckle have been entering the retronasal space as well, it has been much less widespread. Along with seeing these differences between individual flavors, the generic condition was the only condition to not show significant differences in matching ability between flavors. This indicates with the removal of the identity of the samples, the performance between flavors was equalized. From this result, it can be suggested that lavender and rose have a greater name recognition which allowed for a better performance compared to honeysuckle and jasmine due to memory effects from previous experience. This further supports that a different cognitive strategy had to be employed when evaluating the samples with familiar labels that panelists had previous experiences with.

Conclusion

Overall, this work has further supported the Duality of Smells hypothesis proposed by Rozin (1982), indicating this hypothesis is not dependent on the novelty of the stimuli. Although significant differences were not observed when comparing between labeling conditions, there was an observed impact on the task based on the level of provided information when looking at differences between each labeling method. Additional work should be explored to further reduce possible limitations to better observe this effect and determine the extent cognitive strategy plays in olfaction.

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